- **Terms**
  - ***Describe*** involves identifying, naming, drawing, giving characteristics of, giving an account of, defining and/or carrying out simple calculations.
  - ***Explain and apply*** involves describing as well as giving reasons for, making links between chemical concepts and/or observations or carrying out calculations.
  - ***Discuss*** involves showing understanding by analysing, interpreting, justifying, relating, evaluating, comparing and contrasting and/or calculating.

# Specific Learning Outcomes

(As you complete each item, tick the box.)

You should be able to ...

### Equilibrium

- write definitions or explanations for the following terms: dynamic equilibrium, equilibrium mixture, forward reaction, reverse reaction, equilibrium position, closed system, open system. ☐
- write equilibrium constant expressions for a range of reaction equations. ☐
- describe the effect of pressure, temperature, concentration and catalysts on equilibrium systems. ☐
- explain the significance of the magnitude of $K_c$. ☐
- recover silver from silver chloride experimentally. ☐
- carry out an experiment to observe the common ion effect. ☐
- describe important industrial applications of the common ion effect. ☐

### Dissolution Reactions

- determine experimentally by gravimetric analysis the $K_s$ of a sparingly soluble salt. ☐
- calculate the solubility of salts given their $K_s$ values. ☐
- calculate the ionic product and use this to predict whether precipitation will occur. ☐
- use $K_s$ values to describe the solubility of a range of salts. ☐
- recover silver from silver chloride experimentally. ☐
- carry out an experiment to observe the common ion effect. ☐
- describe important industrial applications of the common ion effect. ☐
- use your knowledge of the common ion effect to predict equilibrium concentrations of ions. ☐

### Acid-Base Reactions

- determine experimentally the effect of dilution on the pH of weak acids. ☐
- determine experimentally the $K_a$ of ethanoic acid. ☐
- determine experimentally the extent of solubility of a range of substances. ☐
- determine experimentally the conductivity of a range of substances and classify them as non-electrolytes, weak electrolytes and strong electrolytes. ☐

- classify a range of substances as acidic, basic or neutral. ☐
- construct bar graphs to show the relative concentrations of species in a range of solutions. ☐
- identify conjugate acid-base pairs. ☐
- use $K_a$ to classify acids as weak or strong. ☐
- determine experimentally the pH range of phenolphthalein, litmus, bromothymol blue and methyl orange indicators. ☐
- define the following terms: species, soluble, insoluble, precipitated, concentrated acid, dilute acid, strong acid, weak acid, titration, end-point, equivalence point, indicator, indicator range. ☐
- select appropriate indicators for acid-base titrations. ☐
- construct a titration curve from experimental measurements. ☐
- sketch the shape of titration curves for strong acid/strong base, strong acid/weak base and weak acid/strong base reactions. ☐
- experimentally determine the effect of adding a range of substances to buffer solutions. ☐
- calculate the pH of buffer solutions. ☐

# Specific Learning Outcomes

(As you complete each item, tick the box.)

You should be able to ...

### Nuclear Transformations (Optional) (Students Note: This sub-section is NOT EXAMINABLE)

- describe the contributions of Dalton, Mendeleev, Rutherford, Chadwick, Becquerel, Curie, Bohr, Friedman, Taylor and Kendel to our current understanding of atomic structure. ☐
- locate transition metals and radioactive elements on the Periodic Table. ☐
- define the terms atom, proton, neutron, nucleus, electron, atomic number, mass number, isotope, allotrope, element, compound. ☐
- calculate the half-life of a known isotope and explain the significance. ☐
- compare and contrast the properties of alpha particles, beta particles and gamma rays. ☐
- write nuclear equations which illustrate alpha and beta decay. ☐
- describe how carbon dating works. ☐
- differentiate between nuclear fusion and fission. ☐
- describe harmful/useful effects and applications of radiation. ☐

### Structure of Atoms and Periodic Trends

- define the term 'atomic radius' and explain periodic trends both across a period and down a group of the Periodic Table. ☐
- define the term 'ionic radius' and explain periodic trends both across a period and down a group of the Periodic Table. ☐
- define ionisation energy and describe associated periodic trends. ☐
- write electron configurations for elements and ions with atomic numbers 1–36 using s, p, d notation. ☐
- define the term 'electronegativity' and describe the associated periodic trends. ☐
- use electronegativities to predict bond type. ☐
- describe how differences in electronegativity lead to polar bonding. ☐
- draw Lewis diagrams for a range of molecules. ☐
- draw and predict the shape of a range of polyatomic molecules. ☐

### Transition Metals

- describe some uses of transition metals. ☐
- describe the colour and oxidation states of a range of transition metal ions (selected from iron, vanadium, chromium, manganese, copper and zinc) and their compounds. ☐
- describe the colour of the transition metal complexes $[CuCl_4]^{2-}$, $[Ag(NH_3)_2]^{+}$, $[Cu(NH_3)_4]^{2+}$, $[Zn(NH_3)_4]^{2+}$, $[Zn(OH)_4]^{2-}$, $[Al(OH)_4]^{-}$, $[FeSCN]^{2+}$, aquo complexes of iron(III), chromium(III) and copper(II). ☐
- investigate the catalytic properties of transition metals. ☐

## Thermochemical Principles

- define the terms enthalpy, heat content, H, exothermic, endothermic, $\Delta_r H°$, conservation of energy, thermochemical equation. ☐
- identify the type of intermolecular forces (hydrogen bonds, dispersion forces, dipole-diole forces) found in a range of molecules. ☐
- define and explain molar heat of vapourisation ($\Delta_{vap}H°$) and molar heat of fusion ($\Delta_{fus}H°$). ☐
- define and explain molar heat of vapourisation ($\Delta_{vap}H°$) and molar heat of fusion ($\Delta_{fus}H°$). ☐
- experimentally determine the melting point and freezing point of a pure substance. ☐
- identify, describe and explain periodic trends in identified groups. ☐
- define the terms dispersion forces, hydrogen bonding and dipole-dipole forces. ☐
- calculate heats of combustion using experimental data. ☐
- perform calculations involving the use of specific heat capacity. ☐
- experimentally determine heats of combustion ($\Delta_c H°$) of a range of alcohols. ☐
- carry out a practical exercise to illustrate Hess's Law. ☐
- use Hess's Law to calculate enthalpy changes. ☐
- experimentally determine the enthalpy of combustion of pentan-1-ol. ☐
- use bond energies to calculate enthalpy changes. ☐

# Specific Learning Outcomes

(As you complete each item, tick the box.)

You should be able to ...

### Oxidants and Reductants

- carry out a series of reactions to illustrate oxidation and reduction. ☐
- write balanced half-equations and full equations for a range of redox reactions. ☐
- recognise and identify the colour of a range of oxidants and reductants and any associated colour changes. ☐
- define the terms oxidation, reduction, oxidant, oxidising agent, reductant, reducing agent, spectator ion. ☐

### Electrochemical Cells

- carry out an experiment to observe electron transfer when reactants are physically separated. ☐
- define the following terms: electrolyte, anode, cathode, salt bridge. ☐
- write ionic equations to describe the reactions occurring in an electrochemical cell. ☐
- construct a range of electrochemical cells and measure the voltages produced. ☐
- label diagrams of electrochemical cells to show cell contents, electrode polarity and direction of electron flow. ☐
- construct and investigate the composition of a dry cell. ☐
- construct a lead-acid cell. ☐
- calculate cell voltages using E° values from data books. ☐
- use E° values to predict if a reaction will occur spontaneously. ☐
- describe the contribution of Galvani, Volta, Daniell, Leclanché and Edison to the development of electrochemical cells. ☐
- describe and label the functions of the key features of electrochemical cells. ☐

# Specific Learning Outcomes

(As you complete each item, tick the box.)

You should be able to ...

**Classifying, Naming and Drawing**

- classify and distinguish between the following compounds: alkane, alkene, alkyne, haloalkane, ester, carboxylic acid, alcohol, aldelyde, ketone, amine, primary amide and acyl chloride. ☐
- name and draw compounds of the above groups containing 8 or less carbon atoms. ☐
- recognise the above functional groups in more complex compounds. ☐

**Alkanes, Alkenes and Alkynes**

- distinguish between saturated and unsaturated compounds using bromine water, potassium permanganate and potassium dichromate solution. ☐
- compare the solubility and density of alkanes and alkenes. ☐
- write balanced equations for the complete combustion of alkanes, alkenes and alkynes. ☐
- write balanced equations for the reaction of alkenes, alkenes and alkynes with halogens and hydrogen halides. ☐

**Isomerism**

- construct, draw and name constitutional (structural) isomers. ☐
- identify and name geometric isomers. ☐
- construct and identify optical isomers. ☐
- explain the terms cis, trans, enantiomers, asymmetric, optical, geometric, constitutional, chiral, dextrorotatory, laevorotatory. ☐
- compare and contrast the properties of cis and trans isomers. ☐
- identify asymmetric carbon atoms. ☐

**Alcohols**

- describe the common physical and chemical properties of alcohols. ☐
- draw and name a range of alcohols. ☐
- distinguish between $1^{\circ}$, $2^{\circ}$ and $3^{\circ}$ alcohols using chemical tests. ☐
- name and draw the oxidation products of $1^{\circ}$, $2^{\circ}$ and $3^{\circ}$ alcohols. ☐
- compare the reactions of $1^{\circ}$, $2^{\circ}$ and $3^{\circ}$ alcohols with oxidants. ☐
- write chemical equations to show the reaction of $1^{\circ}$, $2^{\circ}$, $3^{\circ}$ alcohols. ☐
- describe how a breathalyser test works. ☐

**Haloalkanes**

- prepare a haloalkane from its parent alcohol. ☐
- write balanced equations to show the formation of a haloalkane from an alcohol. ☐
- experimentally determine the rate of hydrolysis of a range of haloalkanes. ☐
- explain differences in rates of hydrolysis using polarity, bond angles and bond lengths. ☐
- classify haloalkanes as $1^{\circ}$, $2^{\circ}$ or $3^{\circ}$. ☐

**Amines**

- compare the properties of amines and ammonia. ☐
- write the equation for the reaction of amines with HCl. ☐
- write the formulae of complex ions formed by the reaction of ammonia and amines with copper sulfate. ☐

**Aldehydes and Ketones**

- prepare aldehydes and ketones from their parent alcohol. ☐
- write ion-electron equations for the oxidation of alcohols. ☐
- distinguish between aldehydes and ketones using potassium dichromate, Tollens' reagent and Benedict's solution. ☐
- test sucrose and glucose using Tollens' and Benedict's tests. ☐

**Carboxylic Acids and Derivatives**

- write equations for reaction of carboxylic acids with water, bases, metals and carbonates. ☐
- describe how carboxylic acids are manufactured commercially. ☐
- prepare esters from a range of carboxylic acids and alcohols. ☐
- write fomulae and names for a range of esters. ☐
- carry out a quantitative analysis to determine the percentage yield of ethyl ethanoate prepared from ethanol and ethanoic acid. ☐
- hydrolyse an ester and separate out the alcohol and carboxylic acid produced. ☐
- write balanced equations for the hydrolysis of esters. ☐
- describe the structure of fats and oils. ☐
- explain the process of saponification. ☐
- prepare an acyl chloride and investigate its properties and reactions with water, silver nitrate, ethanol and ammonia. ☐

**Polymers**

- distinguish between addition and condensation polymers. ☐
- name some polymers formed from addition reactions. ☐
- describe the structure of protein and carbohydrates. ☐
- carry out the hydrolysis of a primary amide. ☐
- observe the synthesis of nylon from diaminohexane and sebacoyl chloride. ☐
- describe properties of amino acids. ☐

**Reaction Schemes**

- name reagents and write equations for individual steps in an organic reaction scheme. ☐

## Specific Learning Outcomes

(As you complete each item, tick the box.)

You should be able to ...

- write reduction half-equations for a range of oxidants. ☐
- write oxidation half-equations for a range of reductants. ☐
- write balanced equations for a range of redox reactions. ☐
- describe how to carry out a titration. ☐
- define the following terms: oxidant, reductant, oxidising agent, reducing agent, titre, concordant titre, primary standard, endpoint, equivalence point. ☐
- prepare and calculate the concentration of a standard solution. ☐
- carry out a redox titration to standardise potassium permanganate solution using iron(II) and oxalic acid solutions. ☐
- calculate concentrations of unknown solutions using data obtained experimentally by titration. ☐
- experimentally determine the percentage of iron in steel wool. ☐
- standardise sodium thiosulfate solution using potassium permanganate solution. ☐
- analyse the hypochlorite ion concentration in household bleach and compare it to the manufacturer's specifications. ☐
- experimentally determine the percentage of copper found in brass. ☐